NHP

TECHNICAL NEWS

Issue 12

Please circulate to

Quarterly Technical Newsletter of Australia's leading supplier of low-voltage motor control and switchgear.

IN THIS ISSUE

ELECTRICAL LIFE OF CONTACTORS

Manufacturers provide details of the expected service life of contactors, by testing the contactor under standard test conditions, but the actual service life will depend on many factors. The ability to judge the degree of erosion of contacts can avoid premature replacement of the contactor.

Electrical life

The electrical life of switchgear is defined by the total number of possible operating cycles under operating conditions. When this number is reached, the wearing parts must be inspected.

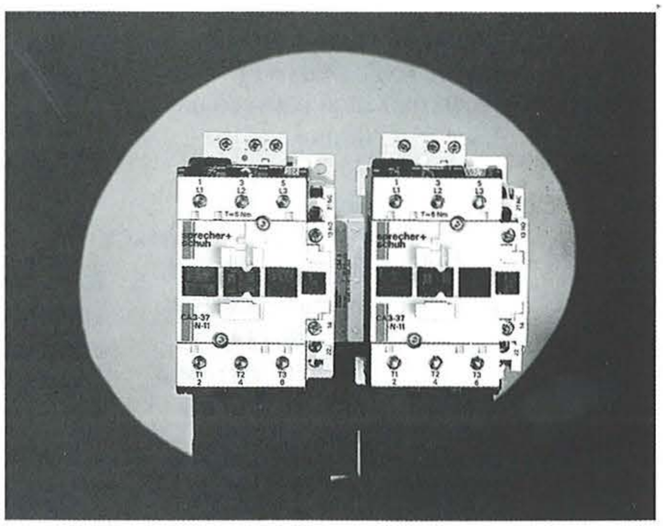
Since contactors are used in a great variety of applications the required number of operating cycles may range from a few thousand to one million or, in the case of small contactors and control relays, ten million cycles and more.

The specific type of application also determines the stress of the contacts and the resulting burn-off. Contact burn-off is influenced (under AC loads) by the following factors in their order of importance -

- ❑ breaking current
- ❑ making current
- ❑ voltage
- ❑ power factor cos φ override of permissible switching frequency
- ❑ interference to equipment from other units (chatter, short circuits)
- ❑ ambient conditions (climate, temperature, vibrations).

Determining electrical life

Tests to determine electrical life are very expensive (test equipment, consumption



Typical modern contactor

Determining electrical life
(continued from page 1)

of test specimens, energy requirements). To avoid false results due to the excessive heating of contacts, the permissible switching frequency must never be exceeded, thus making each test a very time consuming process. As a consequence, electrical life is usually tested by manufacturers rather than by test institutions.

To enable comparison and selection of switchgear, the specifications for the various utilisation categories state exact test values. The design of the test circuit is also determined in detail. To define the end of the electrical life of a device, however, is still a matter of judgement. According to the specification contactors must still pass a functional and a reduced dielectric test. In practical operations additional criteria such as heat-up, contact rating and short circuit strength must be considered. These criteria are applied when the electrical life of Sprecher + Schuh contactors are determined.

Under AC control there is always some degree of synchronisation between the disconnect timing and the supply phase. If the controlling unit is a relay or similar device which also tends to switch synchronously with the supply voltage phase, the synchronisation effect may become very dominant. As a result, making and breaking of three phase loads always affects the contacts of the same pole and they will burn off much faster than those of the other poles.

If the electrical life tests are executed with arbitrary control (such as DC control) the very long electric life obtained in calculations will be reduced in practical operation with AC control by the synchronisation effect.

Note -
Uniform burn-off of all three phase contacts can be obtained by periodically changing over the phases of the AC control circuit.

Data on electrical life

The electrical life of a device, determined under test conditions for the various utilisation categories, is usually expressed in a graph as a function of the rated operational current. These values provide a sound general basis for selecting contactors. In practical operations any deviation of the main influencing factor - (the breaking current) - will be on the safe side: after run-up the motor usually carries a smaller current than its rated operational current and in a prolonged inching phase the breakaway starting current is already slightly reduced.

This usually compensates for the influence of unfavourable circumstances which may not have been observed.

In the Sprecher + Schuh contactor catalogues the electrical life for the most frequent applications is indicated in four different graphs.

1. AC 3, switching of run-up squirrel cage motors. The same graph applies to.

AC 2, run-up slip ring motors (starting current smaller than AC 3 but higher recovery voltage and poorer cos φ when switching off).

AC 1, non-inductive or slightly inductive load, resistance furnaces (starting current smaller and cos φ better than AC 3 but full recovery voltage when switching off).

2. AC 2, inching operation of slip ring motors.

3. AC 4, inching operation of squirrel cage motors.

4. Mixed operation of squirrel cage motors.

AC 3 90 per cent switching of run-up motor.

AC 4 10 per cent inching.

The electrical life for these utilisation categories can also be taken from graph Fig. 1 (refer page 3). With this graph the electrical life for any application (for example, inching of motors with very high or very low starting currents) including any form of mixed operation can be determined.

Example

Situation:
Squirrel cage motor 7.5kW, 380V, 16A, AC 3 (switched off only when the motor is running), operation cycle 2 minutes ON/ 2 minutes OFF, three short operations, anticipated service life eight years.

Required:
Contactor selection.

Solution:
Breaking current = rated operational current = 16A.

Data on electrical life
(continued from page 2)

2 minutes ON + 2 minutes OFF = 15 operating cycles per hour - that is, for three shift operations in eight years according to the graph.

Fig. 1 = 1 million operating cycles.

For breaking current 16A and one million operating cycles, the graph suggests contactor CA 3-16 (see □ □ □ □).

Evaluation of contact condition

The contact surface of a new contact system is by no means smooth, but consists rather of a large number of small surfaces through which the partial currents flow from the fixed contact to the moving contact. The reason for this is the "natural" roughness of the surface of the contact plate, which does not affect the practical function of the contact.

Distinctly visible traces of erosion are left behind by the very first switchings and after a larger number of switchings are distributed over the entire contact surface. After a small number of switchings the entire contact surface is rough and blackened. Notched edges and erosion tapering toward the arcing chamber are also normal signs of wear.

Switching elements of silver alloys have the characteristic that they retain the favourable characteristics with regard to contact reliability, closing capability and current carrying capacity even with an eroded surface.

Under no circumstances may rough contact surfaces be filed smooth, because such action will not improve the switching performance and valuable contact material would only be lost.

It is particularly important for the contact making to occur exclusively with the silver plating; whether the plating is smooth or eroded is not so important. The end of the contact element service life is reached when larger pieces have broken out of the contact plating, or when the danger of contact with the base material exists.

Note that the contact erosion need not be equal in all three poles. This is accomplished by the opening operation with three phase AC (extinguishing phase) and a certain synchronisation of the instant of opening by the control voltage phase angle. The assessment is to be based on the contact element exhibiting the greatest amount of wear.

Legends to figures

As an example evaluation of the contact condition using the 6 main contacts and 3 associated contact bridges of a contactor as follows.

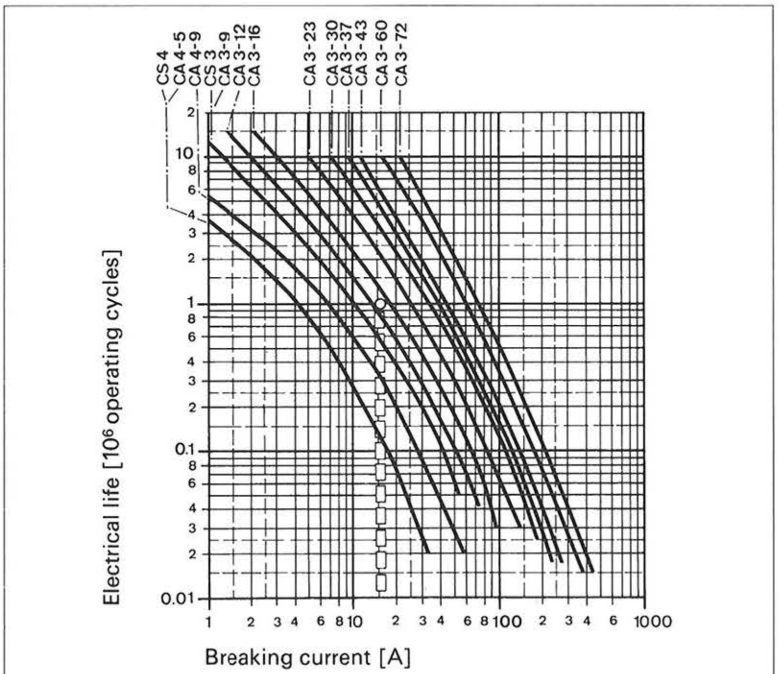
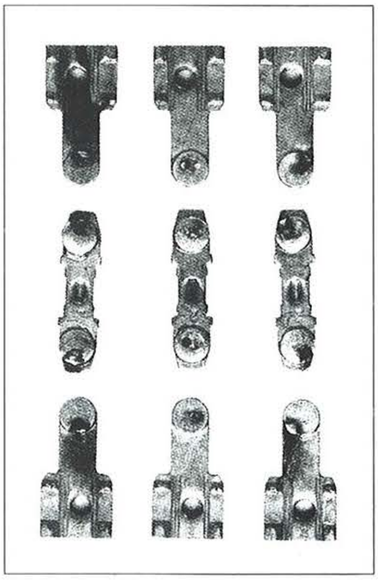


Fig. 1. ***Electrical life of CA 4 and CA 3 contactors as a function of breaking current.***



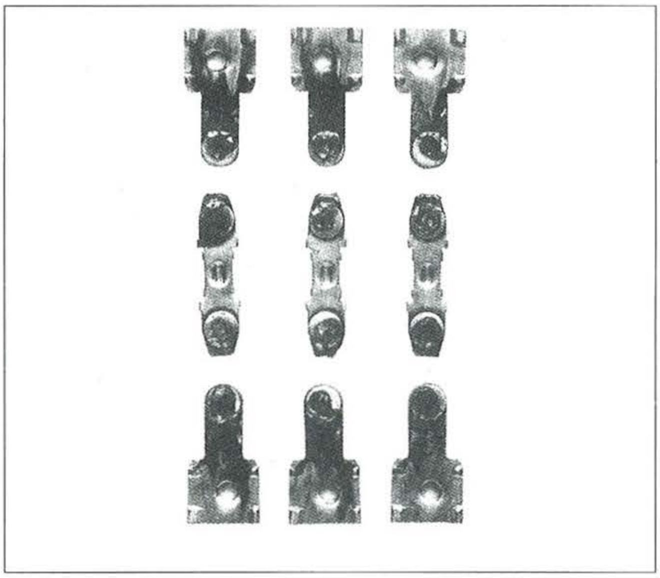
Pic 1. Condition after 1 operation at 8 Ie.

Legends to figures
(continued from page 3)

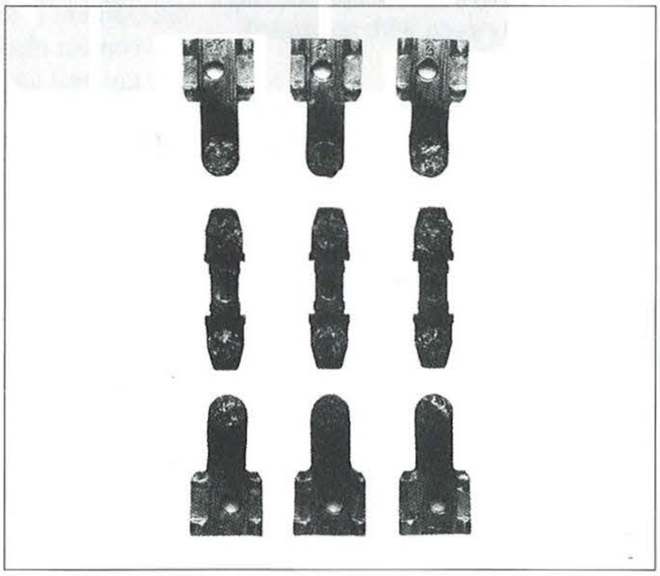
Pic 1. Condition after a single switching operation with 8 Ie.

Pic 2. Condition after double switching capacity test according to IEC 158-1, that is, total of 50 switching operations at 8 Ie. After commissioning the contacts often have the appearance of those illustrated, but are practically in the new condition.

Pic 3. Condition after 0.2 million switching operations at 2.5 Ie. Relatively a lot of contact material is still present, but single cracks and craters reach down to the base material. The end of the contactors service life is now quickly reached it should be taken out of service.



Pic 2. Condition after 50 operations at 8 Ie.



Pic 3. Condition after 0.2 million switching operations at 2.5 Ie.

Editorial content: - Please address all enquiries to 'The Editor - 'NHP Technical News' PO Box 199, Richmond Victoria 3121.

NHP Electrical Engineering Products Pty Ltd A.C.N. 004 304 812

Melbourne
43 - 67 River Street,
Richmond VIC. 3121
Phone: (03) 9429 2999
Fax: (03) 9429 1075

Sydney
30 - 34 Day Street North,
Silverwater N.S.W. 2141
Phone: (02) 748 3444
Fax: (02) 648 4353

Brisbane
25 Turbo Drive,
Coorparoo QLD. 4151
Phone: (07) 3891 6008
Fax: (07) 3891 6139

Adelaide
50 Croydon Road,
Keswick S.A. 5035
Phone: (08) 297 9055
Fax: (08) 371 0962

Perth
38 - 42 Railway Parade,
Bayswater W.A. 6053
Phone: (09) 271 8666
Fax: (09) 272 3906

Newcastle
575 Maitland Road,
Mayfield West N.S.W. 2304
Phone: (049) 60 2220
Fax: (049) 60 2203

Townsville
62 Leyland Street,
Garbutt QLD. 4814
Phone: (077) 79 0700
Fax: (077) 75 1457

Rockhampton
208 Denison Street,
Rockhampton QLD. 4700
Phone: (079) 27 2277
Fax: (079) 22 2947

Toowoomba
Cnr Carroll Street &
Struan Court,
Toowoomba QLD. 4350
Phone: (076) 34 4799
Fax: (076) 33 1796

Darwin
3 Steele Street,
Winnellie N.T. 0820
Phone: (089) 47 2666
Fax: (089) 47 2049

Agents

Hobart
H. M. Bamford (Hobart)
199 Harrington Street,
Hobart TAS. 7000
Phone: (002) 34 9299
Fax: (002) 31 1693

Launceston
H. M. Bamford (Launceston)
59 Garfield Street,
Launceston TAS. 7250
Phone: (003) 44 8811
Fax: (003) 44 4069